

SECTION 15990

TESTING, ADJUSTING, AND BALANCING

1PART - GENERAL

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2.1 Related Documents

- A. All sections of Division 1.
- A. Examine all drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. Work shall be coordinated with other trades prior to installation to prevent interference and relocations.

1.1 Summary

- A. This Section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the air and fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
- A. * Test, adjust, and balance the following mechanical systems:
 - 1. Supply air systems, all pressure ranges;
 - 1. Return air systems;
 - 1. Exhaust air systems;
 - 1. Hydronic systems;
 - 1. Steam distribution systems;
 - 1. Verify temperature control system operation.
- A. This Section does not include:
 - 1. Testing boilers and pressure vessels for compliance with safety codes;
 - 1. Specifications for materials for patching mechanical systems;
- 1. * Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections of the referenced Contract Specifications for materials and installation requirements.
- 1. Requirements and procedures for piping and ductwork systems leakage tests.

1.1 Definitions

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:

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1. the balance of air and water distribution;
 1. adjustment of total system to provide design quantities;
 1. electrical measurement;
 1. verification of performance of all equipment and automatic controls;
- A. Test: To determine quantitative performance of equipment.
- A. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- A. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- A. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- A. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- A. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- A. Main: Duct or Pipe containing the system's major or entire fluid flow.
- A. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- A. Branch main: Duct or pipe serving two or more terminals.
- A. Branch: Duct or pipe serving a single terminal.
- 1.1 **Submittals**
- A. Agency Data:
1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- A. Engineer and Technicians Data:

1. Submit proof that the Test and Balance Technicians proposed to perform the procedures meet the qualifications specified below.
 - A. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
 - A. * Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 1 and Section 15010 of the Contract Specifications.
 - A. Sample Forms: Submit sample forms, if other than those standard forms prepared by the NEBB are proposed.
 - A. Certified Reports: Submit testing, adjusting, and balancing reports bearing the signature of the Test and Balance Technician. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
 1. Draft reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 4 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 1. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.
 1. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a) General Information and Summary
 - b) Air Systems
 - c) Hydronic Systems
 - d) Temperature Control Systems
 - e) * Sound and Vibration Systems
 1. Report Contents: Provide the following minimum information, forms and data:

- a) General Information and Summary: Inside cover sheet to identify testing, adjusting and balancing Contractor, Owner, Engineer, and Project. Include addresses, and contact names and telephone numbers. Include a certification sheet containing the name, address, telephone number, and signature of the Test and Balance Technician. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
 - a) The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the NEBB for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- A. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.1 **Quality Assurance**

- A. Agency Qualifications:
- 1. The work shall be completed by an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
1. * The independent testing, adjusting, and balancing agency shall be certified by National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project, or shall have prior approval from the Engineer. The independent testing, adjusting and balancing agency shall have a minimum of *3 years of experience in those testing and balancing disciplines required for this project. The agency shall provide the name and resume of experience of the technician who will be in charge of services for this project, and references from the owners of no less than 3 unrelated projects tested, adjusted and balanced by the agency. * Resume and references shall be submitted with the priced proposal for Testing, Adjusting and Balancing services.
- * 3. In lieu of satisfying the requirements of paragraph 1.5.A.2, the contractor need not be certified, but rather, have a minimum of ten years experience with similar projects. The contractor shall provide suitable evidence of past performance, including references, justifying the firm's capabilities. This does not relieve the contractor from the provisions specified in paragraph 1.5.B.

- A. Codes and Standards:

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 1. ASHRAE: ASHRAE Handbook, 1995 HVAC Applications Volume, Chapter 34, Testing, Adjusting, and Balancing.
- A. * Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer, maintenance personnel, and *representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.1 **Project Conditions**

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.1 **Sequencing and Scheduling**

- A. Test, adjust, and balance the air systems before hydronic and steam systems.
- A. Test, adjust and balance heating systems during winter season, including at least a period of operation at outside conditions within 10°F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

1PART - PRODUCTS (Not Used)

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3PART - EXECUTION

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4.1 **Preliminary Procedures For Air System Balancing**

- A. Before operating the system, perform these steps:
1. * Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
 1. * Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
 1. * Compare design to installed equipment and field installations.
 1. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 1. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans. Check automatic dampers for proper position.

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1. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
1. Determine best locations in main and branch ductwork for most accurate duct traverses.
1. Place volume dampers in the full open position.
1. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting. Label outlets consistently with report.
1. Check filters for cleanliness and proper installation.
1. Lubricate all motors and bearings.
1. Check motor voltage and amperage.
1. Check fan belt tension.
1. Check fan rotation.
1. Prepare report of recommendations for correcting unsatisfactory conditions which will prevent the systems from being successfully balanced.

1.1 **Preliminary Procedures For Hydronic System Balancing**

A. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
1. Remove and clean all strainers.
1. Examine hydronic systems and determine if water has been treated and cleaned.
1. Check pump rotation.
1. Clean and set automatic fill valves for required system pressure.
1. Check compression tanks to determine that they are not air or water bound and that the system is completely full of water.
1. Check air vents at high points of systems and determine if all are installed and operating. Bleed air completely.
1. Set temperature controls so all coils, including all hydronic terminal units, are calling for full flow.

1. Check operation of all automatic bypass valves.
1. Lubricate all motors and bearings.
1. Check motor voltage and amperage.

1.1 **Measurements**

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- A. Provide instruments meeting the specifications of the referenced standards.
- A. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- A. Apply instrument as recommended by the manufacturer.
- A. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- A. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- A. Take all reading with the eye at the level of the indicated value to prevent parallax.
- A. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- A. Take measurements in the system where best suited to the task.

1.1 **Performing Testing, Adjusting, and Balancing**

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- A. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- A. Patch insulation, ductwork, and housings, using materials identical to those removed.
- A. Seal ducts and piping, and test for and repair leaks.
- A. Seal insulation to re-establish integrity of the vapor barrier.

- A. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- A. Retest, adjust, and balance systems if component test results are more than +/- 5% of design conditions, and subsequent to significant system modifications. Resubmit test results.

1.1 **Record and Report Data**

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as-approved on the sample report forms.
- A. To be of value to the consulting engineer and owner's maintenance department, the air-handling report should consist of at least the following items:

1. Design

- a) Air quantity to be delivered
- b) Fan static pressure
- c) Motor power
- d) Percent of outside air under minimum conditions
- e) Speed of fan
- f) Power required to obtain this air quantity at design static pressure

1. Installation

- a) Equipment manufacturer (indicate model number and serial number)
- b) Size of unit installed
- c) Arrangement of the air-handling unit
- d) Fan class
- e) Nameplate power, nameplate voltage, phase, cycles, and full-load amperes of the motor installed.

1. Field tests

- a) Fan speed
- b) Power readings (voltage, amperes, of all phases at motor terminals)
- c) Total pressure differential across unit components
- d) Fan suction and fan discharge static pressure (equals fan total pressure)
- e) Plot of actual readings on manufacturer's fan performance curve to show the installed fan operating point
- f) Measured airflow rate

1. Terminal Outlets

- a) Outlet by room designation and position

- b) Outlet manufacture and type
- c) Outlet size (manufacturer's size)
- d) Manufacturer's outlet factor (Where no factor is available, or field tests indicate the listed factors are incorrect, a factor must be determined in the field by traverse of a duct leading to a single outlet)
- a) Design air quantity and the required velocity to obtain it
- b) Test velocities and resulting air quantity
- c) Adjustment pattern for every terminal

1. Additional Information

a) Air-handling units

- 1. Belt number and size
- 2. Drive and driven sheave size
- 3. Belt position on adjusted drive sheaves
- 4. Motor speed under full load
- 5. Motor heater size
- 6. Filter type and size, and static pressure across filter when new.
- 7. Existence of vortex or discharge dampers, or both

a) * Distribution system

- 1. Unusual duct arrangements
- 2. Branch duct static readings in double-duct and induction system
- 3. Ceiling pressure readings where plenum ceiling distribution is being used; tightness of ceiling
- 4. Relationship of building to outdoor pressure under both minimum and maximum outdoor air
- 5. Induction unit manufacturer and size (including required air quantity and plenum pressures for each unit) and a test plenum pressure and resulting primary air delivery from the manufacturer's listed curves

a) Ensure that all equipment nameplates are visible and easily readable

- A. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be-successfully balanced.

1.1 **Demonstration**

A. Training:

- 1. * Train the owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 1 and section 15010 of the referenced Contract Specifications.

1. Schedule training with owner through the Engineer with at least 7 days prior notice.

END OF SECTION 15990

Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be-successfully balanced.